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Asymmetric regional dynamics: from bust to recovery

Fernando Alexandre* Hélder Costa† Miguel Portela‡ Miguel Rodrigues§

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Abstract

Regional convergence stands out in the severe adjustment of the Portuguese economy that followed the international financial crisis. This result contrasts with increasing regional inequality in other European countries. We show that regions' GDP growth rates of the Portuguese economy were driven by debt and exports. Our estimates suggest that differences in regional debt-to-GDP and exports-to-GDP ratios resulted in asymmetric regional economic dynamics. Highly indebted regions had a more severe recession and a slower recovery. Regions more open to trade had a milder recession and a stronger recovery. Finally, our results suggest that fiscal decentralization may improve regions' resilience.

Keywords: regional development, economic convergence, debt, exports, local government, fiscal decentralization, resilience, international financial crisis, Eurozone crisis.

JEL Classification: *E32*, *E44*, *F34*, *H63*, *H71*, *H72*, *R11*, *R51*

1 Introduction

This paper aims at contributing to a better understanding of the spatial impact of the international financial crisis and of the Eurozone crisis. In the 2008-2016 recession and recovery cycle of the Portuguese economy, aggregate divergence in real GDP per capita

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relative to the EU–28 coincided with strong regional convergence. This result contrasts with regional economic divergence in most European countries, namely in the ones that were most affected by the international financial crisis and by the Eurozone crisis - see, for example, OECD (2018). We expect that by identifying the main determinants of the asymmetric regional dynamics of the Portuguese economy we may contribute to a better understanding of the regional effects of financial crisis and to contribute to the design of policies that enhance the resilience of regions and countries.

The Portuguese crisis was a debt crisis. Corroborating the predictions based on historical evidence on financial crisis – see, for example, Reinhart and Rogoff (2009) –, the adjustment process (which included a bail out by the International Monetary Fund, the European Commission and the European Central Bank, aka troika, in June 2011) featured a deep recession, that reached a trough in the beginning of 2013. The expansion that followed was very slow and fragile. As a result, between 2008 and 2016, the Portuguese economy has diverged from European Union (EU–28) real GDP. However, during the cycle of recession and recovery (2008–2016), the Portuguese economy registered the greatest decrease in regional GDP inequalities in the EU–28. The coincidence of an aggregate divergence in real GDP relative to the EU–28 with a strong regional GDP convergence was the main motivation for writing this paper.

The huge increase in the indebtedness of the Portuguese economy was asymmetrically distributed across regions. The results of a new research avenue on the impact of financial crises suggest that regions with higher debt to income ratios are expected to suffer deeper and longer recessions and weaker expansions, due to a strong contraction in the consumption of durables – see, for example, Mian and Sufi (2016). Therefore, an asymmetric distribution of debt across regions is expected to affect the impact of the jump in interest rates that followed the sudden-stop of capital inflows to the Portuguese economy during the international financial crisis and the Eurozone crisis. Counter-cyclical measures that could reduce the external finance premium of the Portuguese economy and cushion the impact of the financial crisis depended on the European Central Bank (ECB) monetary policy decisions. However, in its decisions, the ECB should not take into consideration the economic conditions of specific Eurozone countries, and certainly not of specific regions within individual countries. Therefore, more indebted regions could not expect to be helped by ECB counter-cyclical policies. In this context, regions with higher debt to GDP ratios should suffer the most from shocks in financial markets, namely through a higher reduction in households' consumption and firms' investment. These predictions, which correspond to our first testable hypothesis, are corroborated by the estimates presented in this paper.

Large capital inflows from other Eurozone countries reflected large current account deficits and translated into a very negative net international investment position, that

surpassed 100% of GDP in 2008. The allocation of those capital flows to low productivity growth non-tradable sectors – e.g., housing, real estate, retail and public consumption – has been mentioned as one of the main causes of the low growth regime of the Portuguese economy in the 21st century – see, for example, Reis (2013) and Alexandre et al. (2016). Additionally, the growth of non-tradables inflated costs contributed to the deterioration of external competitiveness. In the context of a deep contraction of domestic demand, the growth of exports became a priority, both as an engine of economic growth and as way to restore external balance. Although within the Eurozone an exchange rate devaluation was not an option to boost external competitiveness, the adjustment process has led to a depreciation of the real effective exchange rate. This improvement in the economy's competitiveness was visible in the increasing weight of exports on GDP, which rose from 30% in 2010 to 43% in 2016. We hypothesize that the impact of the real exchange rate depreciation is expected to have favored economic growth in regions with a higher weight of tradables sectors, that is, more open to international trade. In fact, the estimates presented in this paper corroborate our second testable hypothesis, showing that regions with a higher weight of exports on GDP have had a milder recession and a stronger recovery.

Asymmetries in debt-to-GDP ratios and in sectoral specialization (namely, in the weight of exports on GDP) may lead to idiosyncratic regional business cycles - e.g., Groot et al. (2011). Economic theory suggests that in this case regional policies may foster the resilience of regions to shocks - see, for example, Martin et al. (2016). The resilience and the reaction of regions to recessions, namely to the Great Recession of 2008, has drawn the attention of researchers – see, for example, Martin et al. (2016) and Bailey and Berkeley (2014). Global trends and the accelerated technological transformation demand policies adapted to specific realities - e.g., OECD (2018) - and, also, more flexible local governments to implement strategies that improve their competitiveness and that protect them from idiosyncratic shocks.

Portugal is a very centralized country, with a very low weight of local governments expenditures on total government expenditure. Therefore, local governments have a very small share of resources at their disposal to define and build regionally fitted polices. Additionally, the very high public debt and budget deficits imposed a very demanding fiscal consolidation process. This resulted in a strong decrease of transfers to local governments, reducing even further the scope for the implementation of locally defined measures aimed at enhancing the resilience of regions to economic shocks. In this context, local governments were left with the option of increasing their own revenues, that is, revenues that depend on the level of economic activity and on municipalities' policy choices. Notwithstanding, our third testable hypothesis is that own revenues help regions to insulate from shocks. The empirical results presented in this paper suggest

that the weight of own revenues on total revenues of municipalities have a positive impact on regions' economic growth.

The paper is organized as follows. In section 2, we present the main facts on the macroeconomic and regional economic growth of the Portuguese economy in the period that followed the international financial crisis of 2008. In section 3, we discuss the potential role of two important drivers of the economic and financial crisis and of the recovery that followed, namely debt and exports, and describe their asymmetric regional distribution. In section 4, we show the differences in sectoral specialization of regions, its implications for idiosyncratic regional business cycles and we discuss the role of fiscal autonomy in insulating regions from shocks. In section 5, we present the econometric strategy used to test our three hypotheses, the data and the results. Section 6 concludes.

2 Aggregate divergence and regional convergence

The international financial crisis of 2008 resulted in the greatest GDP contraction in developed countries since the Great Depression of the 1930s. In Table 1, we present the data for real GDP growth rates in several European Union (EU–28) countries, for the periods 2008–2012 and 2008–2016. According to the Center for Economic Policy Research business cycle dating for the euro area, the 1^{st} quarter of 2008 marks the peak of the business cycle before the international financial crisis and the 1^{st} quarter of 2013 marks the trough of the business cycle after the recession originated by the Euro sovereign debt crisis.[1] Portugal belongs to the group of countries with the deepest recession, having had a 12% drop in real GDP between 2008 and 2012, only surpassed by Greece (-29%) and Spain (-13%). During the recession in the Eurozone, real GDP in the EU–28 decreased by 6%, 2% in France, 7% in the United Kingdom, whereas in Germany real GDP has increased by 1%.

During the expansion phase of the economic cycle, the Portuguese economy was also in the group with the slowest recovery among EU–28. By 2016 real GDP was still 5% below its 2008 level. In the period 2008-2016, only Greece (-33%), Spain (-7%) and Italy (-7%) had a worse performance, whereas real GDP in the EU–28 and in Germany was already 2% and 12% higher, respectively, than in 2008. As a result, between 2008 and 2016, the Portuguese real GDP *per capita*, as a percentage of the EU–28, decreased from 81% to 77%, hitting a minimum of 75% in 2012. Therefore, the period beginning with the international financial crisis of 2008 was a period of aggregate economic divergence relative to EU–28.

In Table 1, in order to describe the evolution of regional convergence in the period

[1]Between March 2009 and October 2010 there was a very short-lived expansion. For more details, see https://cepr.org/content/euro-area-business-cycle-dating-committee.

Table 1: GDP growth and regional convergence

Country	Δ GDP (2015 prices)		Coefficient of variation, NUTS III regions		
	2008–2012	2008–2016	2008	2015	Δ 2008–2015
Portugal	-12%	-5%	0.25	0.22	-12%
Greece	-29%	-33%	0.30	0.30	1%
Spain	-13%	-7%	0.20	0.21	7%
Italy	-9%	-7%	0.26	0.27	4%
EU–28	-6%	2%			
Germany	1%	12%	0.40	0.39	-2%
France	-2%	3%	0.35	0.37	6%
United Kingdom	-7%	2%	1.00	1.07	7%

Source: Own computations using data from Eurostat. The coefficient of variation of regional (NUTS III) real GDP per capita is computed as the within year standard-deviation of real GDP per capita divided by its mean across the regions. GDP per capita data was only available until 2015. Δ stands for variation.

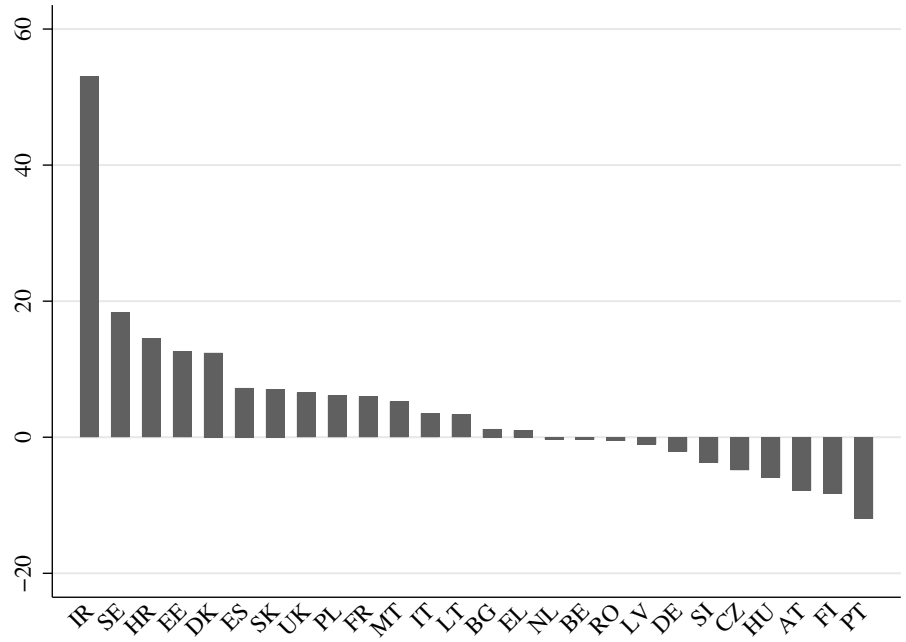
2008–2015, we present data for the coefficient of variation for 2008 and 2015,[2] using NUTS III regions real GDP *per capita*.[3] The results show that Portugal stands out as the only bailed out economy that has registered a strong decrease in regional income inequality (-12%). According to the coefficient of variation, Greece (1%), Spain (7%) and Italy (4%) have all increased the dispersion of income across regions in the period following the international financial crisis.[4]

In fact, Fratesi and Rodríguez-Pose (2016), Iammarino et al. (2018) and the European Commission (2017), among others, have noticed an increase in regional income inequality in several countries in the aftermath of the international financial crisis. However, the evolution of regional inequalities with the business cycle differ across time and space. Groot et al. (2011), for example, shows heterogeneous spatial effects of the international financial crisis, as a result of differences in the openness to trade, financial markets, institutions and in the sectoral composition of countries and regions. Greece seems to be a good example of the difficulties in establishing a relation between the evolution of regional disparities and the business cycle. Petrakos et al. (2005) conclude that regional inequalities in Greece increased during periods of economic growth and decreased during recessions. However, this result contrasts with the conclusions pre-

[2]The coefficient of variation measures σ –convergence, that is, the evolution of the dispersion of real GDP per capita across regions. In section 5, we evaluate β –convergence, that is, the partial correlation between growth in real GDP per capita over time and its initial level, through regression analysis.

[3]NUTS is the European Union nomenclature for territorial statistical units. Portugal is subdivided into three NUTS I regions (Mainland, Azores and Madeira), seven NUTS II regions, and 25 NUTS III regions. Each NUTS III region aggregates several municipalities. Statistics describing NUTS III regions, namely GDP per capita, share in total GDP and population, population density and the number of municipalities, can be found in Table A1 in the Appendix.

[4]Computations for the Gini Index confirm the results from the coefficient of variation.



Source: Own computations using Eurostat. Acronyms: Austria (AT), Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Germany (DE), Denmark (DK), Estonia (EE), Greece (EL), Spain (ES), Finland (FI), France (FR), Croatia (HR), Hungary (HU), Italy (IT), Lithuania (LT), Latvia (LV), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Sweden (SE), Slovenia (SI), Slovakia (SK), United Kingdom (UK).

Figure 1: Δ Coefficient of variation NUTS III regions (2008 – 2015), EU countries

sented in Petrakos and Psycharis (2015). These authors, in an analysis of the spatial impact of the recent financial and economic crisis in Greece, conclude that regional disparities increased. Therefore, even when dealing with the impact of a global international financial crisis and crisis in the Eurozone, we have to be very carefull in the analysis of the specific conditions of each country.

To describe the evolution of regional GDP *per capita* inequality, we have computed the coefficient of variation for NUTS III regions real GDP *per capita* in 26 EU countries, between 2008 and 2015 – see Figure 1.[5] Data in Figure 1 show that, between 2008 and 2015, 14 out of the 25 EU countries had an increase in regional GDP *per capita* dispersion: Sweden, Hungary, Estonia and Denmark present the highest increase in the coefficient of variation – all above 10%. On the other hand, 11 countries have had a decrease in regional GDP inequality after 2008 (although Netherlands, Belgium and Romania have registered a very small decrease in the coefficient of variation). These results show that Portugal stands out has the country with the highest decrease in the coefficient of variation, in the period 2008–2015. That is, during the economic

[5]We excluded Cyprus and Luxembourg from our analysis because they only have one NUT III region.

and financial crisis and in its aftermath, the aggregate divergence of the Portuguese economy coincided with regional economic convergence.

Table 2: GDP *per capita* growth rate, NUTS III (2015 prices)

	2008–2012	2012–2016	2008–2016
Portugal	-12%	11%	-2%
Baixo Alentejo	0%	9%	9%
Douro	-2%	14%	12%
Terras de Trás-os-Montes	-9%	18%	7%
Alto Tâmega	-5%	10%	4%
Alentejo Litoral	-17%	29%	7%
Alto Minho	-2%	14%	11%
Tâmega e Sousa	-6%	14%	7%
Beira Baixa	4%	4%	9%
Beiras e Serra da Estrela	-6%	17%	10%
Cávado	-9%	15%	5%
Ave	-4%	20%	15%
Viseu Dão Lafões	-9%	10%	1%
Alto Alentejo	-11%	18%	5%
Região de Coimbra	-9%	11%	1%
Algarve	-17%	16%	-3%
Região de Leiria	-11%	14%	1%
Região de Aveiro	-10%	15%	3%
Médio Tejo	-9%	11%	1%
AM Porto	-12%	12%	-2%
Oeste	-12%	12%	-2%
AM Lisboa	-15%	5%	-10%
Lezíria do Tejo	-15%	10%	-6%
Alentejo Central	-11%	12%	0%

Source: Own computations using data from INE.

For a better understanding of the regional economic dynamics during the crisis and its aftermath, Table 2 presents the data for real GDP *per capita* growth of the Portuguese economy and its 23 NUTS III regions, for the periods 2008–2012, 2012–2016 and 2008–2016.[6] In the period 2008-2016, real GDP *per capita* decreased by 2%, as a result of the -12% fall in the recession and the 11% increase in the expansion phase.

[6]In our analysis we exclude the regions of Madeira and Açores, because their insular economies are very specific. In the Appendix, Table A1, we describe the main features of the 23 NUTS III regions. There are substantial disparities across the geographical units. The share of both GDP and population ranges between 1% and 36%. AM Lisboa, which includes the Portuguese capital, stands out as the most relevant unit; 36% of GDP and 27% of population, with a population density above 1,000. It is followed by AM Porto, with 16% of the national GDP, 17% of its population, and the highest population density (above 800). The two geographical units are similar in terms of number of cities with a population above fifty thousand inhabitants, and in number of municipalities. AM Porto has a substantial higher number of parishes; 173 compared with 118 in AM Lisboa. The NUTS III that follow AM Lisboa and AM Porto are Algarve, Cávado, Ave, Região de Aveiro and Região de Coimbra, with a share in national GDP bounded between 3% and 4%; the population share is between 2% and 4%. On the lower size extreme, are Alto Tâmega, Terras de Trás-os-Montes, Beira Baixa and Alto Alentejo.

In 2016, there were five regions with a lower real GDP *per capita* than in 2008: Algarve (-3%), Área Metropolitana do Porto (AM Porto) (-2%), Oeste (-2%), Lezíria do Tejo (-6%) and Área Metropolitana de Lisboa (AM Lisboa) (-10%). On the other hand, the highest GDP growth *per capita* was in the regions of Ave (15%), Douro (12%) and Alto Minho (11%).

Table 2 also shows that regional real GDP *per capita* growth patterns were very diverse, both in the recession and in the recovery periods. On the one hand, some regions had a much more severe recession than others: in Alentejo Litoral (-17%), Algarve (-17%), Leziria do Tejo (-15%) and AM Lisboa (-15%) real GDP *per capita* decreased more than the average of the national economy (-12%). On the other hand, some regions, like Douro (-2%), Alto Minho (-2%) or Ave (-4%), had much milder recessions.

In 2013, the Portuguese economy entered a slow but steady path of recovery, leading to an increase of 11% in real GDP *per capita*, between 2012–2016. However, as in the recession, the economic recovery was asymmetric across regions. Some regions have had a much stronger recovery, with higher than average real GDP *per capita* growth rates: Alentejo Litoral (+29%), Ave (+20%), Alto Minho and Tâmega e Sousa (+14%). On the other hand, six regions have had lower than average growth rates of real GDP *per capita* between 2012–2016: Alto Tâmega (10%), Viseu Dão Lafões (10%), Leziria do Tejo (10%), Baixo Alentejo (9%), AM Lisboa (5%) and Beira Baixa (4%). Once again, the AM Lisboa region stands out as the one with the lowest real GDP *per capita* growth rate during the recovery period.

The AM Lisboa region, the richest Portuguese region, which accounted for 36% of aggregate GDP in 2016 (38% in 2009, that is, a decrease of about 5% in its share), stands out as the region with the worst economic performance of all regions in the period 2008-2016. The decrease in the share of the capital city region's contribution to the national GDP contrasts with the increasing economic importance of OECD capital regions - e.g., OECD (2018).[7] As a result of that disappointing performance, real GDP *per capita* of the AM Lisboa region decreased from 143% of the national average, in 2008, to 132%, in 2016. As shown by Petrakos and Psycharis (2015), this result contrast with the increasing importance of the region of Athens during the recent financial and economic crisis, which contributed to an increase in regional inequality in Greece, the country that suffered the deepest and longest recession.

Overall, regional differences in real GDP *per capita* were reduced during the recession, starting in 2008, and during the expansion, starting in 2013, resulting in real GDP

[7] According to OECD (2018): "A common phenomenon across the OECD is the high and increasing economic importance of capital regions. On average, they account for more than 26% of national GDP. The median share of capital city regions' contribution to their respective country's GDP increased by almost 12% (i.e. 2.8 percentage points) between 2000 and 2016."

per capita convergence across regions. In the remaining Sections of this paper we will analyse the drivers of that asymmetric regional dynamics.

3 Debt and openness to trade: regional asymmetries

The international financial crisis and the Eurozone crisis were debt crises – see, for example, Reinhart and Rogoff (2009) and Baldwin et al. (2015). The Portuguese crisis that led to a bail out by *troika* was also a debt crisis. Debt crises, namely when they are associated to banking crises, are followed by long and painful adjustment processes (Reinhart and Rogoff, 2009). Debt was therefore one of the main drivers of the Portuguese economy in the recession and in the recovery following the international financial crisis of 2008–2009 and the euro crisis of 2010–2012.

In the context of a debt crisis and a fiscal consolidation process, exports are the way out of the crisis. The good performance of exports has partially compensated for the contractionary effects of the decrease in consumption, investment and public expenditure, contributing to a milder recession and a stronger recovery. Therefore, we expect regions specialized in non-tradables to suffer deeper and longer recessions and to have a slower recovery than regions more open to trade. On the other hand, regions with an economic structure more dependent on domestic and on public spending are expected to suffer the most from the financial and economic crisis.

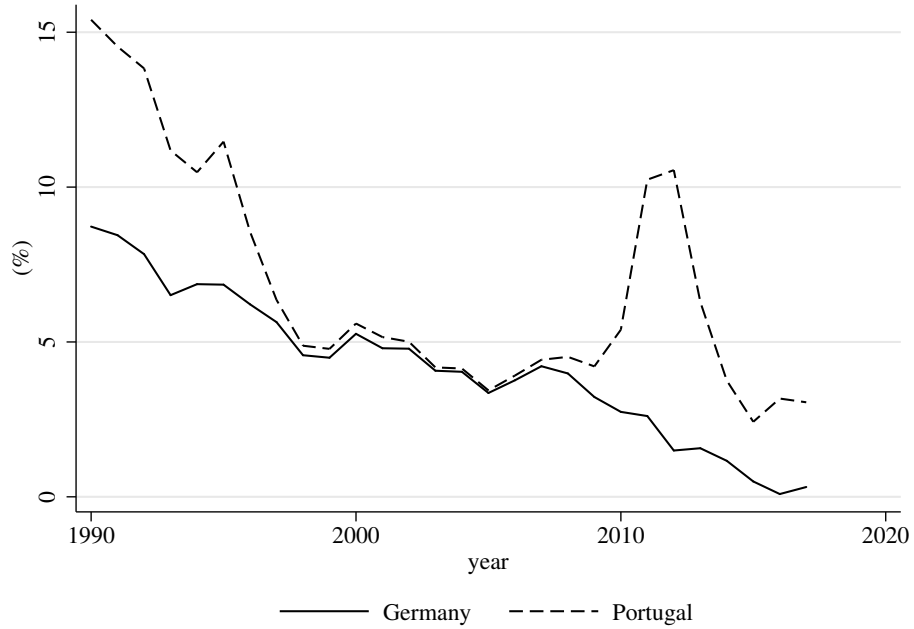
In this section, we describe the asymmetric regional distribution of debt and exports and we discuss its implications for regional economic dynamics during the recession and recovery of the Portuguese economy.

3.1 Debt

The Portuguese financial and economic crisis followed a long period of stagnation since the beginning of the 21st century – Blanchard (2007) provides a thorough (and prescient) description of the period before the international financial crisis of 2008–2009. The accumulation of debt has occurred in the context of low growth and increasing unemployment, which singles out the Portuguese economy from other Eurozone bailed out countries: between 2001 and 2008, the average real GDP growth rate was 1.1%, much lower than growth rates in Spain (3.5%), Greece (4%) and Ireland (5.4%). Despite the low GDP growth rates, the debt (sovereign, firms and households) to GDP ratio increased from 240% in 2001 to over 306% in 2008 (reaching a maximum of 380% in 2012). In the period 1998–2008, Portugal was the OECD economy with the worst

combination of GDP growth and external indebtedness.[8]

The participation in the European Monetary Union was a regime switch in economic policy. Since the mid–1990s, interest rates decreased sharply, converging to German levels – see Figure 2. The creation of the Euro eliminated the exchange rate risk and reduced drastically the interest rate risk premium, lowering the cost of capital: by 2005, Portuguese 10 year bonds' yields were equal to Germany's Treasury rates, having decreased from 15% in 1990 to 3% in 2005. Low interest rates contributed to the huge accumulation of debt and capital inflows, reflecting high current account deficits since the mid–1990s.



Source: Eurostat.

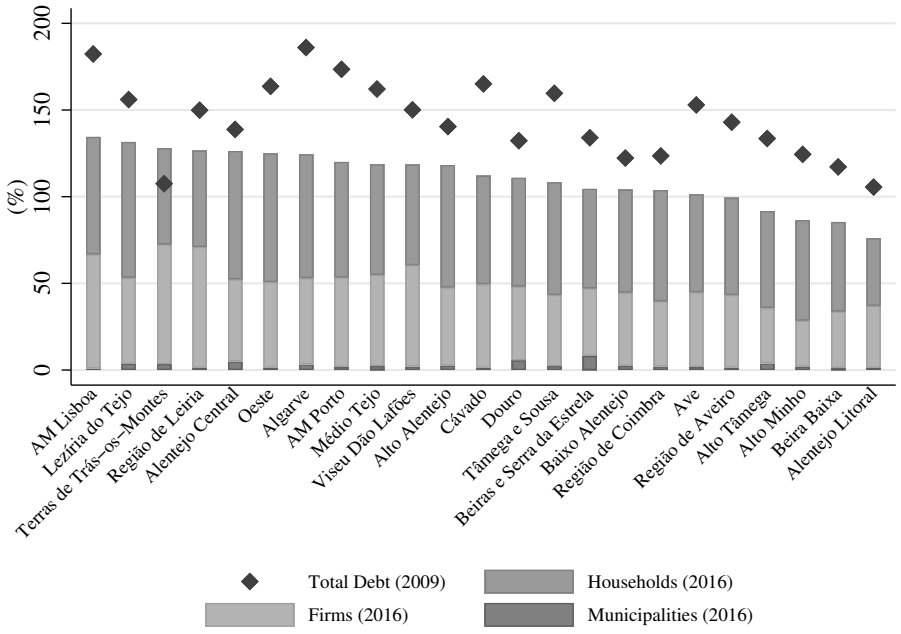
Figure 2: Long term government bond yields – 10 years (%)

In 2008, the negative net international investment position surpassed 100% (it reached a minimum of -119% in 2014). The international financial crisis and the Euro crisis made those imbalances look unsustainable, resulting in a sudden-stop and a jump in the interest rates, from 5% in 2008 to 11% in 2012. In June 2011, the Portuguese economy was bailed out by *troika*. High and increasing public debt called for fiscal consolidation. Expenditure cuts and tax increases had contractionary effects on the economy, causing a deep recession. The condition of public finances was aggravated by the banking crisis and the rescue of banks by the State – the 'diabolic loop' described by Reis (2013). The banking crisis made firms' and households' borrowing constraints more stringent – see, for example, Beck et al. (2017). Changes in the ECB monetary

[8]For a detailed description of the financial imbalances of the Portuguese economy see, for example, Alexandre, Aguiar-Conraria, Bação and Portela (2017).

policy in 2012 – signaled by Mario Draghi's 'whatever it takes to save the Euro' speech – reduced interest rates in the Eurozone: Portugal's 10 year bond yields decreased to 2% in 2015 (Figure 2).

The high stock of private debt, held both by households and firms, was a burden for the economy, constraining households' consumption and firms' investment – see, for example, Rodriguez-Palenzuela and Dees (2016) for an analysis of the Eurozone and Alexandre, Bação, Carreira, Cerejeira, Martins and Portela (2017) for an evaluation of the impact of financial constraints on firms' investment decisions in the Portuguese economy. A new strand of literature has been using microeconomic data to explore the impact of heterogeneity in households' debt levels on the economy – e.g., Mian and Sufi (2010) and Mian and Sufi (2016). These authors conclude that the U.S. counties where households' debt increased the most were the most affected by the crisis, having had a higher contraction in the consumption of durables. In the same vein, studies for the UK (Bunn and Rostom, 2014) and for Denmark (Andersen et al., 2014), using micro data, conclude that high levels of households debt have been associated with deeper and longer recessions and with weaker expansions. These results suggest that the distribution of debt across regions may affect the adjustment process of their economies, with more indebted regions having deeper and longer recessions.[9]



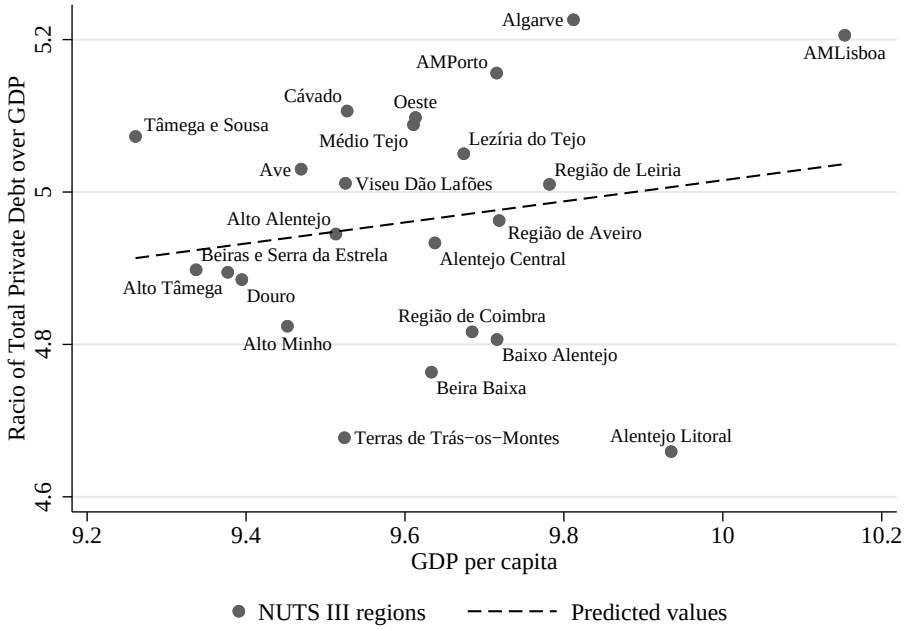
Source: Own computations using data from CCRD, Banco de Portugal and *Anuários Regionais*, INE.

Figure 3: Debt to GDP ratio, NUTS III regions, 2009 and 2016

We use micro data from the *Central Credit Responsibility Database (CCRD)*, col-

[9]For a discussion of the real effects of the financial crisis see, for example, Bernanke (2018).

lected and made available by the Banco de Portugal Microdata Research Laboratory (BPLIM) (Laboratório de Investigação em Microdados do Banco de Portugal). CCRD collects data on the indebtedness of borrowers (including collective persons, individual entrepreneurs and private persons) as reported by credit-granting institutions. Among the information on the indebted individuals (available since 2009) and firms is their location, which allows us to to build data to describe the regional distribution of households and firms' debt and its weight on the GDP of each region – see Figure 3.[10] In our analyis we also consider the debt of municipalities aggregated by NUTS III regions.



Source: Own computations using data from CCRD, Banco de Portugal and *Anuários Regionais*, INE.

Figure 4: Debt to GDP ratio and GDP per capita, NUTS III regions (2009)

Our data shows a high concentration of private and local governments' debt in NUTS III AM Lisboa and AM Porto, amounting to 61% of total debt in 2009 (58% in 2016). Figure 3 shows the debt to GDP ratio for NUTS III regions. Except for Terras de Trás-os-Montes, all regions had a significant reduction in their debt to GDP ratio between 2009 and 2016. The debt data shows that, in 2009, all regions had a debt to GDP ratio above 100%. However, there was a great variation in the debt to GDP ratios across regions, ranging from more than 180% in the regions of Algarve and AM Lisboa, to 102% in Alentejo Litoral. Between 2009 and 2016, the variation in debt to GDP ratio was also significant in the different regions. Algarve has had the highest decrease in this ratio (-61 p.p.), followed by AM Porto, Ave, Cávado and Tâmega e Sousa, all with a decrease of around 50 p.p.. Figure 4 shows a positive relation between

[10]For more details on the CCRD database see Banco de Portugal (2018).

debt-to-GDP ratio and GDP per capita for NUTS III regions, in 2009. This data shows that the richest regions were the more indebted and, therefore, they were expected to suffer more with the financial crisis. In this way, indebtedness may have contributed to regional convergence.

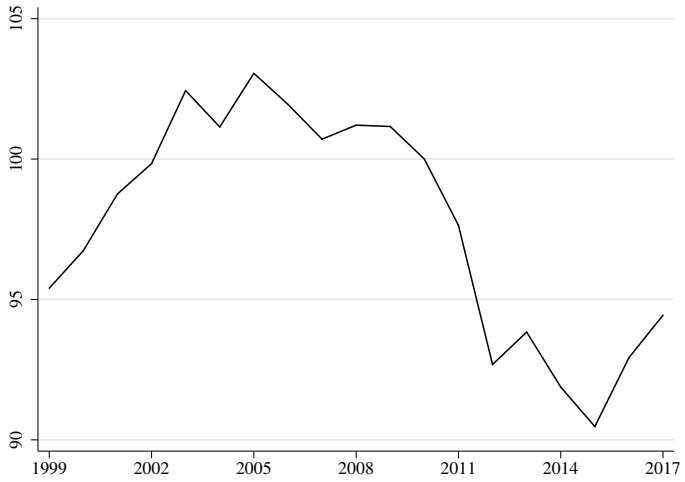
The asymmetric distribution of debt across regions is expected to affect the impact of the financial crisis on the real economy. Regions where households and firms face more stringent borrowing constraints are expected to suffer a stronger adjustment in consumption and investment and, therefore, in their GDP.

3.2 Openness to trade

After a weak performance of exports in the first decade of the 21st century – an average real growth rate of 3.2% between 2000 and 2008 (and a fall of 16.2% in 2009) –, since 2010, exports have been the main driver of economic activity, with an average real growth rate of 6.1%, between 2010 and 2016. This strong increase of exports resulted in an increase in the weight of exports on GDP, from 30% in 2010 to 43% in 2016. This increase in the weight of tradable sectors is one of the most important structural transformations of the Portuguese economy in the last decade. The increase of exports and of its market share may signal the materialization of the medium and long run gains of trade and specialization from the creation of the European Monetary Union, mentioned in Krugman (1993). The good performance of exports made an important contribution to improve the current account from a deficit of around 12% of GDP, in 2008, to a surplus of around 1%, in 2013. Considering the forecasts for 2018, the current account will show a surplus for six years in a row, a historical achievement for the Portuguese economy.

The Eurozone countries cannot boost their exports through currency devaluations, as exchange rates are irreversibly fixed. The real effective exchange rate is country specific, given that it depends on each country's competitiveness conditions, namely the evolution of labor costs, and on its trading partners' competitiveness conditions.[11] Several authors have shown that real exchange rates are important drivers of the reallocation of resources between sectors – e.g., Gourinchas (1998). Economic theory suggests that the impact of exchange rate movements should depend on the degree of exposure to international competition – e.g., Klein et al. (2003). Alexandre et al. (2011) show that exchange rate movements have a larger impact on low-tech sectors and that open economies specialized in high-tech sectors are more insulated from exchange rate shocks. Additionally, Alexandre, Bação, Cerejeira and Portela (2017) conclude that greater labor market rigidity reduces the impact of exchange rate shocks on employ-

[11] For an analysis of the Portuguese real effective exchange rate see, for example, Alexandre et al. (2009)



Source: AMECO.

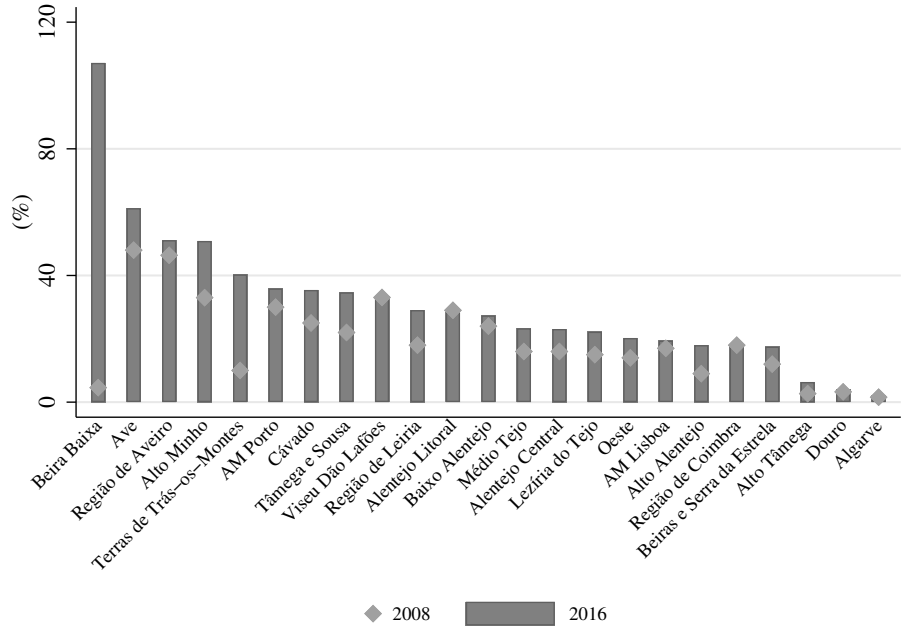
Figure 5: Portuguese real effective exchange rate, 2010 = 100

ment. Labour market reforms, aiming at more flexibility, were part of troika's program of structural reforms – e.g., Blanchard and Portugal (2017). These results suggest that the Portuguese economy, integrated in the EU–28, having a high share of low- and medium-low tech sectors and a more flexible labour market should be very exposed to movements in exchange rates.

Figure 5 shows the Portuguese real effective exchange rate between 1999 and 2016. In the first years of the Euro, between 1999 and 2005, the real effective exchange rate has appreciated by 8%. After a period of stabilization, between 2008 and 2015 the real effective exchange rate has depreciated by 11%. As argued above, the exchange rate depreciation that followed the international financial crisis should have had a positive impact on the competitiveness of the Portuguese economy, favoring the growth of exports. However, the impact of the exchange rate depreciation is expected to have benefited more the regions more open to international competition or with a higher weight of exports on its GDP. We therefore expect regions with a productive structure more oriented to exports to have a milder recession and a more vigorous recovery.

For now, we describe the differences across regions in terms of the weight of exports on GDP – see Figure 6.[12] We use that ratio as a measure of the degree of openness to international trade. The data shows a wide variation of the ratio of exports to GDP across regions, varying from a maximum of 107% in Beira Baixa to almost 0% in regions like Alto Tâmega, Douro and Algarve. OECD (2018) discusses the role of tradables on regional economic performance and argue that a higher exposure to international trade favours convergence. Figure 7 shows a positive relation between the NUTS III regions' growth rate of exports and GDP per capita growth rate, in the period 2008–2016.

[12]We should stress a caveat of our measure of openness to trade, namely that exports do not include tourism.



Source: Own computations using data from INE.

Figure 6: Weight of exports on GDP by NUTS III regions, 2008 and 2016

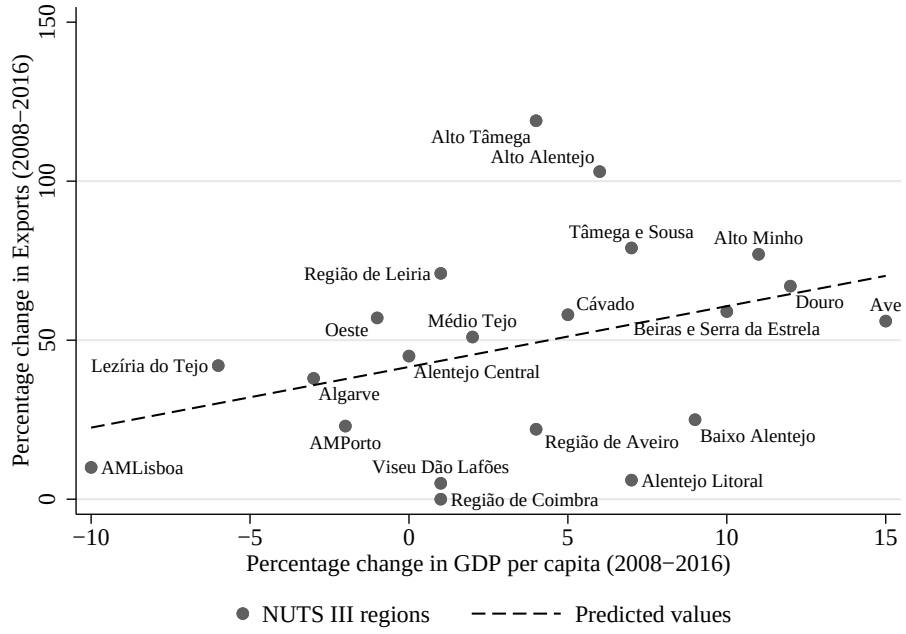
Therefore, differences in the weight of exports to GDP is one dimension of the asymmetries in the economic structure of regions that may affect regional growth. Those asymmetries raise challenges for the definition of national level economic policies and for the definition and implementation of regional and local policies to promote the regions' international competitiveness. In the next section, we discuss the differences in the economic structures and asynchronous regional economic cycles and the role of fiscal decentralization in enhancing regional resilience and growth potential.

4 Asynchronous cycles and regional resilience

In the previous sections we have discussed the impact of aggregate shocks in financial markets, namely in interest and exchange rates. We have also described differences in regional debt-to-GDP and exports-to-GDP ratios. The data presented so far suggests that aggregate shocks may affect regions asymmetrically. In this section, we present evidence of idiosyncratic regional business cycles and discuss the role of regional policies in accommodating external shocks and in enhancing the resilience of regions.

4.1 Asynchronous cycles

Differences in regions' exports-to-GDP ratio, discussed in the previous section, reflect differences in the degree of specialization across regions – Imbs (2004) shows that a



Source: Own computations using data *Anuários Regionais*, INE.

Figure 7: Percentage change in Exports and Percentage change in GDP per capita, NUTS III regions (2008 – 2016)

higher openness to trade results in higher degrees of specialization. Differences in economic structures may affect the synchronization of regional business cycles with the national business cycle.

Figure 8 presents the index of specialization for NUTS III regions, for 2008 and 2016.[13] In the construction of the specialization index we have considered the weight of the sectors in the value added of the economy.[14] The higher the index of specialization, the greater the difference in the sectoral composition of the region relative to the sectoral composition of the national economy. Figure 8 shows that, in 2016, regions like Algarve (38%), Ave (37%), Alentejo Litoral (34%), Baixo Alentejo (33%), Tâmega e Sousa (33%) and Aveiro (32%) have an index of specialization above 30%. On the other hand,

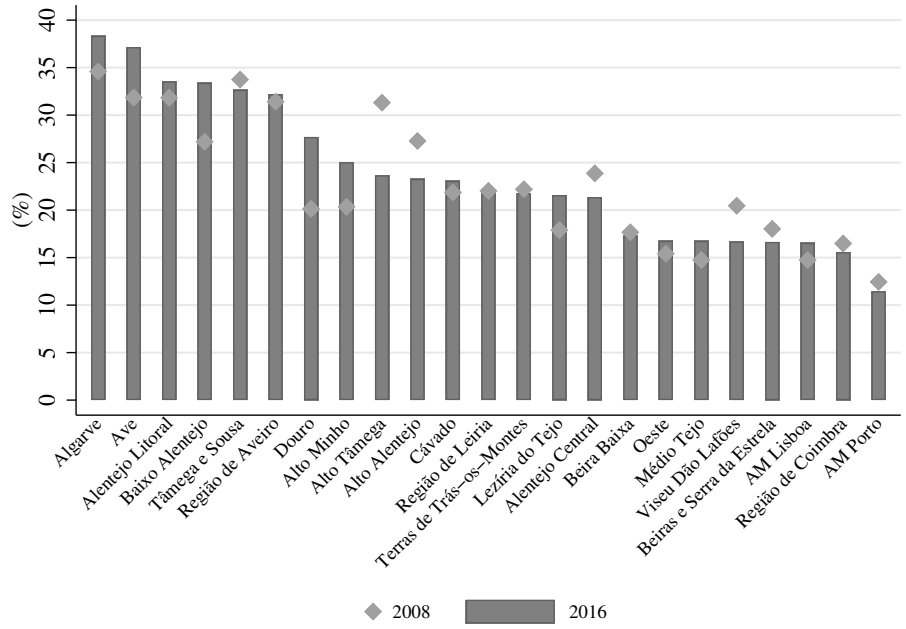
[13]The index of specialization is given by

$$CE_i = 1/2 \sum_{k=1}^{K} \left| \frac{x_{ik}}{x_i} - \frac{x_k}{x} \right|, \qquad CE_i \in [0, 1[$$

where i stands for the region and k stands for the sector.

[14]In 2016, for the aggregate economy, the weights of economic sectors in total value added were the following: Manufacturing (24.2%), Wholesale and retail trade and repair of motor vehicles and motorcycles (19.5%), Transporting and storage (7.7%), Administrative and support service activities (6.7%), Information and Communication (6.5%), Consultancy (6.3%), Construction (6.3%), Accommodation and food service activities (5.3%), Electricity, gas, steam and air conditioning supply (5.0%), Human health and social work activities (3.8%), Real Estate Activities (2.2%), Agriculture (1.8%), Water supply; sewerage; waste management and remediation activities (1.6%), Arts, entertainment and recreation (1.2%), Education (0.9%), Mining and quarrying (0.2%) and Other sectors (0.8%).

regions like AM Lisboa (17%), Coimbra (16%) and AM Porto (11%) have a much lower index of specialization, which indicates that they have an economic structure more similar to the national sectoral composition.



Source: Own computations using data from INE.

Figure 8: Index of specialization, NUTS III (%), 2008 and 2016

Those differences in sectoral specialization may result in idiosyncratic regional business cycles. To evaluate the regional business cycle synchronization, we computed the correlations in economic activity, measured by GDP growth rates, for the period 2000 to 2016, between each region and the national economy, subtracting from it the GDP of the own region. The results, presented in Table 3, show a wide range of correlations, from a maximum of 0.93 to a minimum of 0.54. Our computations allow the identification of three groups of regions. A group where the GDP growth rate correlation with the national GDP growth rate is equal or under 70%: namely Alto Minho, Baixo Alentejo, Beira Baixa, Alentejo Litoral and Ave. A group that show very high correlations (above 90%) of regions' GDP growth with national GDP growth: AM Porto, Algarve, Coimbra, AM Lisboa and Leiria. Finally, the other 12 regions' correlation coefficient lay between 70% a and 90%.

Asynchronous regional business cycles may have implications for the efficacy of national and regional level economic policies when regions are hit by idiosyncratic shocks. Next, we discuss the role and scope of regional and local policies in dampening the regional business cycle.

Table 3: Correlation between regions' and national GDP growth rate, 2000 – 2016

Baixo Alentejo	0.54
Beira Baixa	0.55
Alentejo Litoral	0.56
Ave	0.69
Alto Minho	0.70
Alto Tâmega	0.72
Alentejo Central	0.73
Alto Alentejo	0.74
Douro	0.78
Lezíria do Tejo	0.84
Terras de Trás-os-Montes	0.84
Beiras e Serra da Estrela	0.84
Viseu Dão Lafões	0.85
Oeste	0.86
Médio Tejo	0.86
Região de Aveiro	0.88
Cávado	0.88
Tâmega e Sousa	0.90
Área de Metropolitana do Porto	0.91
Algarve	0.92
Região de Coimbra	0.92
Área Metropolitana de Lisboa	0.92
Região de Leiria	0.93

Source: Own computations using data from INE.

4.2 Regional resilience and fiscal decentralization

The international financial crisis returned to the center stage the debate on the contribution of regional policies to strengthen the resilience of regions to shocks. [15] Throughout the Eurozone crisis, bailed out countries, in the context of high pressure from the financial markets, had to implement strong fiscal consolidation measures – public expenditures cuts and increases in taxes – that resulted in severe recessions, as described in Section 2, without a thorough assessment of its impact at the regional level. On the other hand, ECB monetary policy, a potentially powerful counter-cyclical instrument, does not target the macroeconomic conditions of individual countries, and, obviously, neither does it target the economic conditions of specific regions within each country. Those constraints on fiscal policy, at the national level, and of the monetary policy, at the Eurozone level, raise challenges for the insulation of regional economies from shocks such as the variations in interest rates and exchange rates. On top of this, in the Por-

[15] Bailey and Berkeley (2014) analyses the role of the West Midlands Taskforce in the United Kingdom in the crisis of 2008-2009.

tuguese economy, the definition and implementation of policies at the regional and local levels are limited by the scarce resources available at those levels of administration.

The level of fiscal decentralization is an indicator of the share of responsibilities between the different levels of government (Kyriacou et al., 2017). It is usually measured by the ratio between local government expenditures and total public expenditures. In fact, that measure for several OECD countries shows that Portugal is one of the most centralized countries in OCDE. In 2016, Portugal recorded a 9.5% ratio of financial decentralization, only ahead of countries such as Luxembourg, Bulgaria, Romania and Greece and far away from the 35.1% of Germany, the 33.2% of Spain and the 27.6% of Denmark, the first non-federal country.[16]

According to Eurostat data for Portugal, in 2016, local governments were responsible for 12.7% of total public expenditures, recovering from a minimum low of 11.5% in 2014.[17] The maximum level of fiscal decentralization occurred in 2008, when the share of expenditures by the local government reached up to 15.7%. This data shows that, during the recession that followed the international financial crisis and the Euro sovereign crisis, a lower share of total public expenditure was distributed to local governments. This very low share of local government expenditure suggests that local and regional administration have limited resources to counter the effects of strong aggregate shocks.

In the period 2008–2016, local governments' total revenues declined from a maximum of 7,884 million euro, in 2014, to a minimum of 6,979 million euro, in 2014 (a 11.5% decrease). In 2016, total revenues had recovered 4.6%, to 7,303. The revenues of the local administration can be divided into transfers from the central government and own revenues. The evolution of the two components is displayed in Figure 9 for the period 2008–2016. Transfers from the central government reached a maximum in 2010 – 3,800 million euro – declining steadily henceforth, reaching 3,000 million Euro in 2016, a decrease of 23%. The Financial Equilibrium Fund (FEF), also represented in Figure 9, is main component of central government's transfers to municipalities. Between 2008 and 2016, FEF varied from a minimum of 64% of total transfers, in 2012, to a maximum of 78%, in 2016. In this period, FEF reached a maximum of 2,718 million euro, in 2009 and a minimum of 2,189 million euro in 2014 (a decrease of 24%). FEF aims at providing municipalities with the funds necessary for them to comply with their responsabilities, as defined by law.[18]

As local government faced a substantial reduction in the resources transfered from

[16]The data is available at IMF (2017).

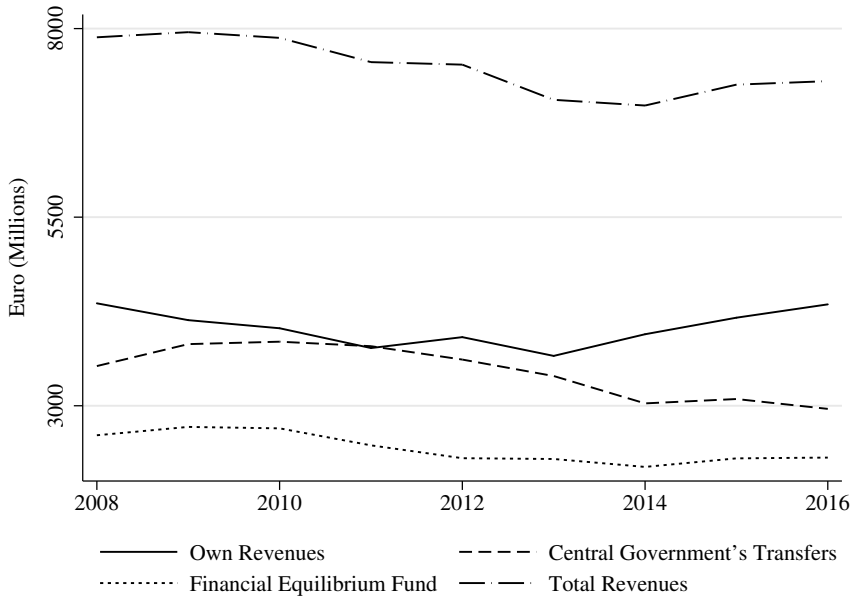
[17]In Portugal, local governments are composed by 278 municipalities in the Continent and by two regional governments in the archipelagoes of Azores (which includes 19 municipalities) and Madeira (which includes 11 municipalities).

[18]See Regime Jurídico das Autarquias Locais, Lei 75/2013 12 de setembro de 2013, http://www.pgdlisboa.pt/leis/lei_mostra_articulado.php?artigo_id=selected&nid=1990&tabela=leis&pagina=1&ficha=1&nversao=.

the central government, they had to focus on their own capabilities to raise revenues. Own revenues of local governments depend, on the one hand, on the economic characteristics of the regions and, on the other hand, on their policy choices. Own Revenues components are described in equation (1),

$$\begin{aligned} OwnRev_{i,t} = \alpha_{i,t} PublicServices_{i,t} + \delta_{i,t} Income_{i,t} \\ +\Omega_{i,t} CorporationProfit_{i,t} + \gamma_{i,t} RealEstateProp_{i,t} \\ +\sigma RealEstateTrans_{i,t} + \theta Mobility_{i,t} \end{aligned} \tag{1}$$

According to equation (1), own revenues of local governments include: (1) the sales of goods and services supplied locally ($PublicServices_{i,t}$), where $\alpha_{i,t}$ represents the price defined by local entities; (2) revenues from the personal income tax ($Income_{i,t}$), where $\delta_{i,t}$ stands for the tax rate defined by local entities and bounded between 0% and 5%; (3) the revenues over the firms' profits ($CorporationProfit_{i,t}$), that may reach a maximum tax rate of 1.5% ($\Omega_{i,t}$); (4) the revenues from real estate property ($RealEstateProp_{i,t}$), where the tax rate may be settled between 0.3% and 0.45% ($\gamma_{i,t}$);[19] (5) additionally, local government get revenues from taxes on sales of real estate ($RealEstateTrans_{i,t}$) and taxes on the use of motor vehicles ($Mobility_{i,t}$); in both cases tax rates (σ,θ) are set by the Central Government.



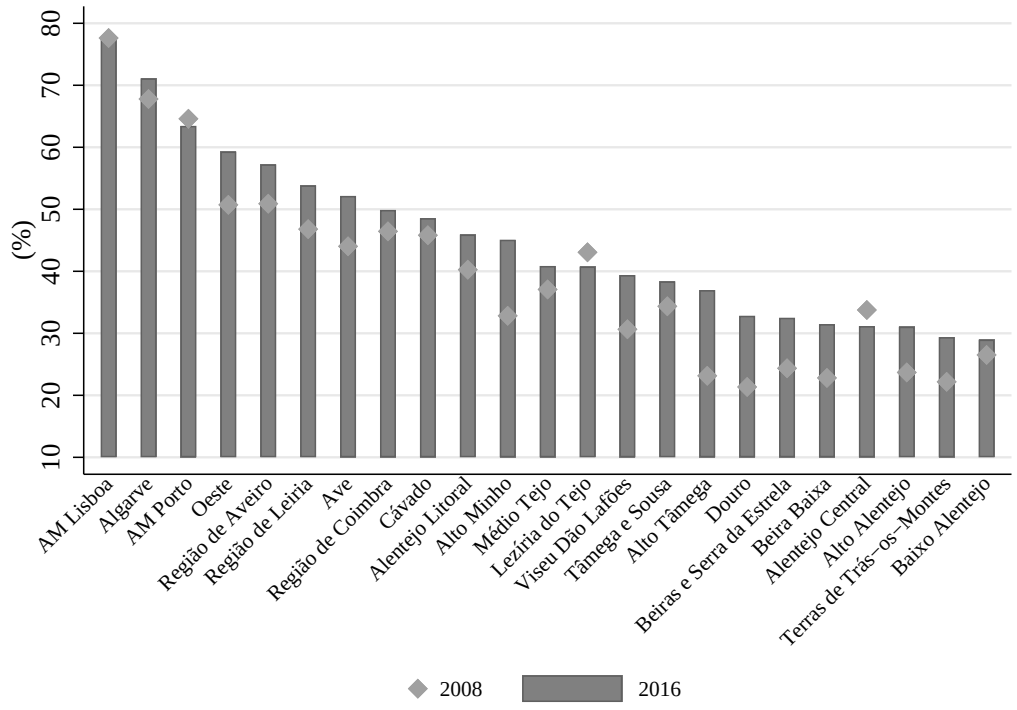
Source: Direcção-Geral das Autarquias Locais (DGAL) and INE.

Figure 9: Local Governments: Own Revenues, Financial Equilibrium Fund and Total Revenues

[19]The equity value is obtained through an administrative evaluation that obeys legal criteria established by the services of the Ministry of Finance. The actual market value at which the transaction is made is not taken into account.

Figure 9 shows a decrease of own revenues of local governments from 4,400 million Euro in 2008 to 3,700 million Euro in 2013 (-16%). Since 2013, own revenues have increased steadily, almost recovering the value of 2008. In 2016, as a result of the described trends in transfers and own revenues, the share of those two components in total revenues of local governments was 40% and 60%, respectively.

Figure 10 shows the weight of own revenues over total revenues for NUTS III regions, for 2008 and 2016. That ratio was computed as an average of the ratio of own revenues to total revenues of the municipalities that belong to each NUTS III region. The great majority of the regions display an increase in the weight of their own revenues. Only the regions of AM Porto, Lezíria do Tejo and Alentejo Central have experienced a minor drop in the weight of own revenues. Regions show a wide range of weights on total revenues, from a maximum of 78% in the AM Lisboa region to a minimum of 29% in the Baixo Alentejo region.



Source: Direcção-Geral das Autarquias Locais (DGAL) and INE.

Figure 10: Variation of the weight of Own Revenues

The variation in the weight of the own revenues, described in Figure 10, reflects the capabilities of the regions to raise taxes over real estate, personal income and corporations' profits. The ability of local governments in each region to raise own revenues, namely in the context of decreasing government transfers, may foster the autonomy of local governments and enhance the resilience of regions to shocks. On

the other hand, own revenues will be highly correlated with the regions' own business cycle, which may condition its ability to deal with specific shocks. In that case, transfers from the central government may be more effective in dampening the region's business cycle. Regions' greater fiscal autonomy also provides local officials with greater decision-making power to design policy options that best serve their constituencies. In the same way, greater financial autonomy can foster the quality of local governance. Additionally, a commitment to decentralization allows for a better identification of the services to be provided with the needs of the community it actually aims to serve – for a detailed discussion of the benefits of decentralization see, for example, Kyriacou et al. (2017), Treisman (2006) and Oates (1999).

In Table 4 we can see that overall the weight of the total revenues over GDP has little variation during the period of analysis. From 4.3% of the GDP in 2008, it dropped to 4.2% in 2016 after recording a small increase in 2012 (4.6%). What has significantly changed is its composition. Transfers from the central government dropped during the crisis and did not recover afterwards (2012-2016), while own revenues fully recovered after recording a drop in the period 2008-2012.

The variation in the central government's transfers is similar across regions. Only the region of AM Lisboa experienced a drop in both periods. The variation of the own revenues was uneven across regions. Some regions recorded a wider increment in its variation (Alto Tâmega, Terras de Trás-os-Montes, Alto Minho) and others experienced a drop from which they are still striving to recover (Beiras e Serra da Estrela, Médio Tejo, Lezírias do Tejo).

In the next section, we estimate the impact of total revenues, FEF and own revenues of local governments' on regional GDP growth. Additionally, we will explore the role of the autonomy of local policies, gauged by the weight of own revenues on total revenues of municipalities, on the the regions' GDP growth.

5 Empirical analysis

The evidence presented in Section 2 suggested that, in the period following the international financial crisis, the aggregate divergence of the Portuguese economy coincided with significant regional σ – convergence. In this section, we use longitudinal data for the 23 Portuguese mainland NUTS III regions, for the period 2008–2016, to estimate a model that aims at identifying the determinants of the asymmetric economic dynamics that resulted in strong regional convergence. The econometric specification follows Durlauf et al. (2009), which allows us to test the papers' hypotheses: (i) was there β – convergence in GDP per capita across regions? (ii) regions with a higher debt-to-GDP ratio went through a deeper and longer recession? (iii) regions with a higher degree

Table 4: Descriptive statistics: variations (%)

	$TotRev/GDP$			$\Delta OwnRev$		ΔFEF	
NUTS III	2008	2012	2016	2008 – 2012	2012 – 2016	2008 – 2012	2012 – 2016
Portugal	4.3	4.6	4.2	-10.1	11.2	-11.9	0.6
Alentejo Central	7.2	7.4	8.6	-12.4	22.3	-11.0	3.0
Alentejo Litoral	5.0	5.9	4.4	-10.2	2.5	-11.0	2.7
Algarve	7.0	6.3	6.9	-26.9	32.7	-19.4	-1.6
Alto Alentejo	11.2	10.5	8.9	-13.0	11.6	-11.5	2.2
Alto Minho	7.1	7.2	6.2	-6.6	29.9	-11.6	2.4
Alto Tâmega	9.8	10.6	10.6	-1.5	36.5	-10.7	3.3
Ave	4.5	5.1	4.3	-4.5	18.7	-11.4	5.0
Baixo Alentejo	8.5	8.1	7.1	-9.1	-1.1	-10.5	2.5
Beira Baixa	8.9	7.9	6.8	-7.4	1.2	-10.9	2.5
Beiras e Serra da Estrela	9.9	9.1	8.5	-13.7	4.6	-10.6	2.8
Cávado	3.9	4.1	3.5	-12.2	14.2	-10.6	3.9
Douro	9.2	9.3	7.6	4.7	15.6	-11.1	4.1
Lezíria do Tejo	5.7	5.2	5.1	-38.0	17.7	-10.7	3.2
Médio Tejo	6.1	6.5	5.1	-28.3	5.1	-17.3	2.1
Oeste	4.8	5.0	4.2	-16.7	13.1	-11.2	2.3
Região de Aveiro	4.4	4.4	3.6	-11.3	25.3	-11.0	-0.0
Região de Coimbra	4.6	5.2	4.7	-8.0	15.9	-10.4	2.0
Região de Leiria	4.2	4.2	3.7	-11.4	23.7	-12.1	4.7
Terras de Trás-os-Montes	9.3	10.3	9.3	5.2	22.5	-11.5	3.0
Tâmega e Sousa	5.7	6.1	5.1	-9.9	13.7	-10.7	4.4
Viseu Dão Lafões	6.1	6.0	5.5	-25.4	20.7	-9.1	1.1
Área Metropolitana de Lisboa	2.7	3.3	2.9	4.5	-2.2	-13.9	-12.0
Área Metropolitana do Porto	3.8	3.5	3.6	-23.8	25.1	-10.4	2.2

Notes: '*TotRev*' and '*OwnRev*' stand for NUTS III's Total and Own Revenues, while 'FEF' stands for Financial Equilibrium Fund (*Fundo de Equilíbrio Financeiro*). NUTS stands for *Nomenclatura das Unidades Territoriais para Fins Estatísticos* and corresponds to the 'Nomenclature of Territorial Units for Statistics' developed by Eurostat.
Sources: Own computations using data from *Direcção-Geral das Autarquias Locais* (DGAL) and INE.

of openness to trade had a better economic performance in terms of economic growth? (iv) what was the role of fiscal decentralization, namely through local governments' own revenues, on regions' economic performance?

We start by describing the data and then we present our econometric strategy and results.

5.1 The data

In our estimates we use yearly longitudinal data for the 23 Portuguese mainland NUTS III regions, for the period 2008–2016. We use regions' real GDP *per capita*, GDP_{pc}, from *Contas Regionais*, INE, as a measure of economic performance. We built a novel data set using detailed information on households' and firms's debt at the regional level, from the Central Credit Responsability Database (CCRD), Banco de Portugal. We use this data to build debt-to-GDP ratios at the regional level, $Debt_{ratio}$. To the best of our knowledge, this is the first paper to use this data at the regional level. The regions' degree of openness to trade is mesasured by the ratio of exports to GDP,

$Exports_{ratio}$, from *Anuários Estatísticos Regionais*, INE. To evaluate the role of fiscal decentralization on regions' growth rates we use local government's revenues data from DGAL and INE, aggregated at NUTS III regions' level. In our estimates we evaluate the impact of local governments' total revenues *per capita*, $TotRev_{pc}$, and of its two main components: the Own Revenues *per capita*, $OwnRev_{pc}$, and the Financial Equilibrium Fund *per capita*, FEF_{pc}. Additionally, to evaluate the importance of the regions' fiscal autonomy on economic growth, in our estimates we also consider the regions' ratio of own revenues over total revenues, $OwnRev_{ratio}$, and the regions' ratio of the Financial Equilibrium Fund over total revenues, FEF_{ratio}. We also include in our model, as control variables, the region's investment rate, Inv, and the percentage change in the regions' employment, Emp, from *Anuários Estatísticos Regionais*, INE. Finally, the variables $Interest$, given by the long term government bond yields (10 years) and the real effective exchange rate, $Exchange$, are collected from Eurostat (2018*b*) and AMECO (2018), respectively. Table A2 reports descriptive statistics of the variables used in our estimates.

5.2 Econometric model and estimation strategy

Given our testable hypotheses and the definition of the variables presented in the previous section, we evaluate the existence of β – convergence, the impact of indebtedness, openness to trade and of fiscal decentralization on regional GDP growth using a general econometric model with the following specification:

$$\begin{aligned} GDP_{\ i,t} = \alpha\ GDP_{\ i,t-1} + \beta_1\ Inv_{\ i,t-1} + \beta_2\ \Delta Emp_{\ i,t} \\ +\beta_3\ Debt_{\ i,t} + \beta_4\ Debt_{\ ratio\ i,t} \times Interest_{\ t} \\ +\beta_5\ Exports_{\ i,t} + \beta_6\ Exports_{\ i,t} \times Exchange_{\ t} \\ +\gamma\ X_{\ i,t} + \eta_i + \varepsilon_{i,t}, \end{aligned} \tag{2}$$

where the vector $X_{i,t}$ is $TotRev_{pc\ i,t}$ in our Model # 1; includes the variables $OwnRev_{pc\ i,t}$ and $FEF_{\ pc\ i,t}$ in Model # 2; is $OwnRev_{ratio\ i,t}$ in Model # 3; and, finally, is $FEF_{ratio\ i,t}$ in Model # 4. With the exception of the interest rate and the exchange rate, all other variables are in logs.

In our estimates, we account for the possibility that the effect of debt-to-GDP ratio on GDP is conditional on the interest rate at the country level, $Interest_t$, by including in equation (2) an interaction between the debt-to-GDP ratio and the interest rate. Likewise, we include an interaction term between the exports-to-GDP ratio and the real effective exchange rate for the Portuguese economy, $Exchange_t$. Finally, in order to control for NUTS III regions unobserved heterogeneity, we consider a region specific

effect, η_i, and a white noise error term, $\varepsilon_{i,t}$.

We apply panel data estimation procedures to the longitudinal data described above to obtain estimates for equation (2). The use of a fixed-effects estimator would introduce an endogeneity problem, namely by creating a non-zero covariance between the within transformed $GDP_{i,t-1}$ and the demeaned $\varepsilon_{i,t}$.[20] To address endogeneity issues we follow Arellano and Bover (1995) and Blundell and Bond (1998) and apply the System–GMM estimator to the dynamic panel data model specified in equation (2). We assume that the variables *Interest* and *Exchange* are treated as exogenous (the remaining variables are treated as endogenous). Given the short number of observations, we use second and third lags of the endogenous variables as instruments for the first-difference equation. For the level equation we applied the usual lagged first-differenced variables as instruments. The exogenous variables are also included in the instrument set. Furthermore, to limit the overall number of instruments, we apply the 'collapsed' instruments as discussed in Roodman (2009). In the computation of the variance-covariance matrix we use the two-step estimation with the finite-sample correction proposed by Windmeijer (2005). The statistics reported in Table 5 are robust to errors' heteroskedasticity and serial correlation. Finally, we report the Hansen consistent test for over-identifying restrictions.[21]

5.3 Results

The results of our estimates are presented in Table 5.[22] Regional β – convergence is confirmed in Models # 1 to # 4. The estimated α is below one and bounded between 0.62 and 0.75 and is always statistically significant at the 1% significance level.

Concerning the three hypotheses of the paper, our findings are the following. In the first place, we found that the debt-to-GDP ratio has a negative effect on the region's economic growth. Using the results of Model # 3, the combination of the parameters associated with the debt to GDP ratio, β_3 and β_4, in equation (2), shows that a 10 p.p. increase in the $Debt_{ratio}$ leads to a 0.4% decrease in GDP.[23] Furthermore, a 1 p.p. increase in the interest rate magnifies the immediate effect by about 0.01 p.p. (statistically significant at the 1%). These results corroborate the hypothesis that a higher debt-to-GDP ratio, in the context of more stringent financial conditions, captured by higher interest rates, has a negative effect on the regions' economic growth.

[20] For a detailed discussion, see, for example, Verbeek (2012)'s Chapter 10. Further insight can be found in Arellano (2003).

[21] For further insights on the use of this methodology see, for example, Costa et al. (2015), who use this estimator to analyse interactions in Portuguese municipalities' spending decisions.

[22] For a discussion of the validity of the estimates see Section A.2 in the Appendix.

[23] The marginal effect is evaluated at the interest rate in 2016, 3.2%, and is statistically significant at the 10% level. Its standard-error, computed by the delta method, is 0.002.

Table 5: Estimation results: System – GMM

	M #1	M #2	M #3	M #4
$ln(GDP_{pc})_{i,t-1}$	0.7483***	0.7450***	0.6212***	0.7502***
	(0.0453)	(0.0239)	(0.0536)	(0.0350)
$ln(Debt_{ratio})_{i,t}$	-0.0174	-0.0243	-0.0372	-0.0308
	(0.0311)	(0.0198)	(0.0231)	(0.0222)
$ln(Debt_{ratio})_{i,t} \times IntRate_t$	-0.0019***	-0.0019***	-0.0015***	-0.0018***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$ln(Exports_{ratio})_{i,t}$	0.1414*	0.0675	0.2124**	0.0714**
	(0.0740)	(0.0409)	(0.0789)	(0.0282)
$ln(Exports_{ratio})_{i,t} \times ExRate_t$	-0.0015**	-0.0008**	-0.0022***	-0.0008***
	(0.0007)	(0.0004)	(0.0007)	(0.0002)
$ln(TotRev_{pc})_{i,t}$	-0.0853***			
	(0.0224)			
$ln(OwnRev_{pc})_{i,t}$		0.0119		
		(0.0294)		
$ln(FEF_{pc})_{i,t}$		-0.0432***		
		(0.0066)		
$ln(OwnRev_{ratio})_{i,t}$			0.0996***	
			(0.0259)	
$ln(FEF_{ratio})_{i,t}$				-0.0553***
				(0.0090)
$AR(1)$	-1.709	-1.882	-2.026	-2.019
$AR(1) - pv$	0.087	0.060	0.043	0.044
$AR(2)$	-1.417	-1.602	-1.488	-1.519
$AR(2) - pv$	0.156	0.109	0.137	0.129
Hansen χ^2	17.223	19.664	18.079	18.888
Hansen (df)	12	14	12	12
Hansen, $p - value$	0.141	0.141	0.113	0.091

Notes: The dependent variable is $ln(GDP_{i,t})$. All models are estimated by System–GMM (all the models include as control variables $Inv_{i,t-1}$ and $\Delta Emp_{i,t}$ as regressors). Robust standard-errors in parenthesis and clustered at NUTS III level. Significance levels: 1%, ***; 5%, **; 10%, *. **Sample size**: 184 observations, 23 NUTS III and 8 time periods. The variables are described in Section 5.1. AR(1) and AR(2) stand for the Arellano-Bond tests for first and second order autocorrelation in the first differences of the idiosyncratic disturbance term, $\Delta\varepsilon_{i,t}$; *pv* stands for *p-value*, while *df* is degrees of freedom. Hansen refers to the test for joint validity of the instruments. Table A1 provides additional information on each NUTS III region. Descriptive statistics are reported in Table A2. See the discussion in the main text for further information.

Concerning our second hypothesis, our results show that openness to trade, measured by the weight of exports on the region's GDP, has a positive impact on GDP, and that effect is magnified by an exchange rate depreciation, has shown in the coefficient of the interaction term between the export ratio and the real effective exchange rate. This parameter is always negative (an increase in the exchange rate represents an appreciation of the domestic currency) and highly significant at 1% level in Model # 3 and at 5% level in the other models. The estimated parameters imply that a 1 p.p. depreciation in the exchange rate increases the immediate effect on GDP *per capita* growth by approximately 0.06 pp (statistically significant at 1%). These results are confirm the findings of Petrakos and Psycharis (2015) for Greece. OECD (2018) also

mention that regions with a higher specialization in the tradable sector converged faster to the most richest regions.

Finally, our last hypothesis deals with the impact of fiscal decentralization on the regions' economic growth, considering total revenues of the municipalities and its main components. Our results show that local governments' total revenues have a negative, and significant at the 1% level, impact on regions' economic growth (Model # 1). This somewhat surprising result suggests that total revenues may be ill-conceived. Therefore, we investigate further the role of local government's revenues by looking at the effects of its two main components: own revenues and the financial equilibrium fund (FEF). Model # 2 shows that own revenues are positive, but statistically not significant, while FEF has a negative, and statistically significant at the 1% level, impact on economic growth. These results reinforce the need of further investigation on the design and effectiveness of local governments' revenues, namely in the context of a severe economic crisis.

In the previous section we have discussed the potential benefits of local governments' fiscal autonomy. In Models # 3 and # 4, we evaluate the impact of increasing the fiscal scope for municipalities, measured by the weight of own revenues in their total revenues. Our results suggest that local governments' with a higher weight of own revenues have a better economic performance – a 1 p.p. increase in the weight of own revenues is associated with a 0.22% increase in GDP (statistically significant at 1%). Reinforcing this result, estimates of Model # 4 show that a higher weight of central government's transfers (FEF) have a negative, and statistically significant at the 1% level, effect on the regions' economic growth: a 1 p.p. increase in weight of FEF over total revenues is associated with a 0.14% decrease in GDP (statistically significant at 1%).

We then run two additional robustness estimations. First, given the weight of AM Lisboa region, the capital's city region, on the economy, we excluded it from our estimates. By running the same regressions as in Table 5, but excluding AM Lisboa from the sample, the results were highly stable in terms of sign, magnitude and validity (the AR(1), AR(2) and Hansen test do not reject the validity of the instruments).

The second robustness check deals with the definition of own revenues, which could reveal itself as a source of extra-endogeneity not entirely solved within the System–GMM estimation strategy. To proceed along this line of discussion, we have considered own revenues excluding income based taxes, IRS and derrama, and re-estimated Model # 3. The results do not reject the validity of the main results reported under column M# 3.

Finally, we explored if the results could be driven by hand-picking the set of instruments we use. This is a key critique to the Dynamic System–GMM, as its results could be highly sensitive to the specific instruments one uses. Maintaining our assumptions

on model formulation, particularly the assumptions on endogeneity and exogeneity, we have estimated model M#5 with different sets of instruments by using different lags. All the results we obtain are consistent with the ones reported in column M#5.[24]

6 Concluding remarks

This paper aims at contributing to a better understanding of the spatial impact of the international financial crisis. The identification of the determinants of the regions' economic dynamics during the financial and economic crisis may contribute to the design of better policies, that is, policies that take into account the specific conditions of the regions. This may result in more resilient regions and in a stronger aggregate performance of the economy.

During the economic cycle that started with the international financial crisis of 2008, the aggregate divergence in real GDP *per capita* relative to the EU–28 coincided with a strong regional GDP *per capita* convergence. In fact, in the period 2008–2015, Portugal stands out as the EU–28 country with highest decrease in GDP *per capita* regional inequality. We then explored the relation of the regional dynamics with two important economic drivers in this business cycle of recession and recovery: debt and exports. Economic literature suggests that regions with higher debt-to-GDP ratios should have a more severe recession and a weaker recovery, given the impact of financial constraints on households' consumption and firms' investment decisions. Our estimates corroborate that hypothesis, showing that more indebted regions had a worse economic performance following the international financial crisis. Such effects were magnified by variations in the interest rates.

The high share of non-tradable sectors has been among the main culprits of the low-growth regime of the Portuguese economy in the 21st century. In the context of a strong contraction in domestic demand and a fiscal consolidation process, exports were crucial, both as an engine of economic growth and in the correction of current account imbalances. The economic literature has shown that real effective exchange rates have an impact in economic growth. This impact is magnified in open economies specialized in low-tech sectors. Our estimates suggest that regions more open to international trade were more resilient to the contraction in domestic demand and were more capable of benefiting from the recovery of the international economy and from real exchange rate depreciations.

In this paper, we also show the existence of asynchronous regional business cycles. In this context, we explored the role of local governments' own revenues in regions' economic growth. Our estimates indicate that the increase in fiscal autonomy of local

[24]Detailed results are available upon request.

governments, measured by the weight of own revenues on total revenues, may enhance the regions' resilience and growth.

It also follows from the discussion above that regions' economic performance may benefit from a more decentralized structure of governance, based on own revenues, as long as it is framed by a stringent control over local governments' indebtedness. Furthermore, regions' transition from bust to recovery could be accelerated by policies that promote tradable sectors.

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A Appendix

A.1 Descriptive statistics

Table A1: Descriptive statistics by NUTS III, Portugal mainland, 2016

NUTS III	GDP *per capita*	Share GDP	Share Pop.	Pop. Dens.	# Municipalities: Pop. over 50k	# Municipalities	# Parishes
Alentejo Central	15,802	1.4%	1.6%	22	1	14	69
Alentejo Litoral	26,398	1.4%	1.0%	18	0	5	31
Algarve	18,854	4.7%	4.5%	90	3	16	67
Alto Alentejo	14,216	0.9%	1.1%	18	0	15	69
Alto Minho	13,787	1.8%	2.4%	108	1	10	208
Alto Tâmega	12,021	0.6%	0.9%	31	0	6	118
Área Metropolitana de Lisboa	23,578	37.6%	28.8%	1003	16	18	118
Área Metropolitana do Porto	16,913	16.5%	17.5%	849	12	17	173
Ave	15,305	3.6%	4.2%	288	3	8	168
Baixo Alentejo	16,995	1.1%	1.2%	14	0	13	62
Beira Baixa	16,512	0.8%	0.8%	18	1	6	59
Beiras e Serra da Estrela	12,429	1.5%	2.2%	35	1	15	266
Cávado	14,559	3.3%	4.1%	329	2	6	170
Douro	13,200	1.4%	2.0%	49	1	19	217
Lezíria do Tejo	15,164	2.1%	2.4%	57	1	11	68
Médio Tejo	15,171	2.0%	2.4%	72	0	13	93
Oeste	14,807	3.0%	3.6%	162	3	12	89
Região de Aveiro	17,482	3.6%	3.7%	222	2	11	74
Região de Coimbra	16,255	4.0%	4.5%	103	2	19	168
Região de Leiria	18,114	2.9%	2.9%	118	2	10	67
Tâmega e Sousa	11,239	2.7%	4.3%	233	5	11	177
Terras de Trás-os-Montes	14,377	0.9%	1.1%	20	0	9	195
Viseu Dão Lafões	13,956	2.0%	2.6%	80	1	14	156

Source: Own computations using data from Eurostat, European Commission and Statistics Portugal (INE). GDP *per capita* is in Euro. 'Pop.' stands for population; 'Dens.' is density; '50k' represents fifty thousand inhabitants; # represents the number of observations, either municipalities or parishes. In 2015, mainland Portugal has 278 Municipalities and 2,882 parishes.

Table A2: Descriptive statistics

	GDP_{pc}	ΔGDP_{pc}	Inv	Emp	$Debt_{ratio}$	$Exports_{ratio}$	$TotRev_{pc}$	$OwnRev_{pc}$	FEF_{pc}	$OwnRev_{ratio}$	FEF_{ratio}
						2009					
Mean	15241.1	-0.4	11.8	3.7	144.5	16.9	1025.6	350.3	408.8	0.36	0.38
sd	3310.2	4.2	2.3	1.2	22.3	10.8	302.1	140.0	203.5	0.13	0.11
Min	10519.1	-15.7	7.1	1.9	105.6	1.2	586.9	192.5	121.1	0.19	0.16
Max	25678.8	6.8	17.9	6.4	186.1	44.5	1446.3	824.1	772.1	0.69	0.53
						2012					
Mean	13945.4	-5.6	7.4	2.9	140.5	25.3	883.3	326.1	351.7	0.39	0.38
sd	2917.9	2.5	2.3	2.0	20.6	14.0	252.9	109.9	178.8	0.13	0.11
Min	9809.0	-11.2	3.6	0.0	101.8	2.0	510.6	187.3	101.0	0.24	0.14
Max	22169.0	0.9	13.3	7.0	177.8	57.5	1261.6	682.7	668.2	0.75	0.53
						2016					
Mean	15865.9	3.0	7.9	8.1	111.1	30.8	906.1	390.3	376.5	0.45	0.40
sd	3429.1	1.2	1.8	1.4	16.0	22.2	284.1	136.2	199.0	0.14	0.13
Min	11171.0	0.2	5.0	4.6	76.0	2.0	506.0	218.5	88.9	0.29	0.13
Max	26238.5	4.9	12.0	11.3	134.6	107.1	1350.5	913.7	720.8	0.78	0.60

Notes: GDP_{pc} is expressed in Euro; all other numbers are expressed as percentages. 'sd' stands for standard-deviation; 'Min' for minimum and 'Max' for maximum. In each year the number of observations is 23, corresponding to the number of NUTS III. The sample used to compute these statistics is the same as the one used in the regressions presented in Table 5.
Sources: Own computations using data from AMECO, Banco de Portugal, Eurostat and INE.

A.2 Discussion of the validity of the estimates in Table 5

Following Arellano and Bond (1991) we evaluate the validity of the instrument set using the statistics AR(1), AR(2) and the Hansen test. Looking to Model # 1, we observe that the AR(1) test, with a statistic of -1.71, is statistically different from 0 at the 10% significance level, which indicates that we reject the null hypothesis of no serial correlation in the first-difference residual, $\Delta\varepsilon_{i,t}$. Looking to the AR(2) test, we do not reject the null of absence of correlation between $\Delta\varepsilon_{i,t}$ and $\Delta\varepsilon_{i,t-2}$. This implies that there is no serial correlation in $\varepsilon_{i,t}$, validating the use of lags 2 and more of the endogenous variables in equation (2). Furthermore, the (robust) Hansen statistic, $\chi^2_{(12)}$ of 17.2, is statistically non-significant. This set of results lead us to conclude in favour of the validity of our estimates. As discussed in Arellano (2003), we take an additional step and evaluate if using the System–GMM, as discussed in Arellano and Bover (1995) and Blundell and Bond (1998), improves on the First–Differences solution discussed in Arellano and Bond (1991). The Difference–in–Hansen tests for the validity of the additional instruments used in System–GMM, as compared to the First–Differences set of instruments, do not reject the null that the First–Differences of the added set of instruments are uncorrelated with the fixed effects. Relevant statistics: (1) GMM instruments for levels, Hansen test excluding group, $\chi^2_{(6)} = 11.92$ (*p-value = 0.06*), Difference (null, exogeneity), $\chi^2_{(6)} = 5.30$ (*p-value = 0.51*); (2) IV for exogenous variables, exchange rate and interest rate, Hansen test excluding group, $\chi^2_{(10)}) = 17.02$ (*p-value = 0.07*), Difference (null, exogeneity), $\chi^2_{(2)} = 0.20$ (*p-value = 0.91*). Such result is an extra validation of our estimates. These conclusions extend to the estimates of Models # 2, # 3 and # 4 presented in Table 5.

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